

CLAIMS

1. A magnetic actuator including a mobile magnetic portion (20), a fixed magnetic portion (10) provided with at least two attraction areas (11, 12) for the mobile magnetic portion (20), and means (30) for triggering the displacement of the mobile magnetic portion (20), the mobile magnetic portion (20) being in levitation when it is not in contact with an attraction area (11, 12), characterized in that the mobile magnetic portion (20) includes a magnet-based part (200) with reduced magnet weight, this part (200) having an overall volume, and a mass which is less than the one it would have if its overall volume was totally occupied by the magnet.

2. The magnetic actuator according to claim 1, characterized in that the part (200) with reduced magnet weight includes one or more magnets (22, 24, 26) provided with at least one recess (21, 27).

3. The magnetic actuator according to claim 2, characterized in that the recess (21) is a through-hole.

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4. The magnetic actuator according to any of claims 2 or 3, characterized in that the recess (21) is filled with a solid material (25) with lesser density, less than that of the magnet (24).

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5. The magnetic actuator according to claim 4, characterized in that the lesser density solid material is selected from semiconducting material, plastic material, soft magnetic material, dielectric material.

6. The magnetic actuator according to any of claims 2 or 3, characterized in that the recess (21) is empty of solid material.

7. The magnetic actuator according to any of claims 1 to 6, characterized in that the part (200) with reduced magnet weight is a substantially rectangular plate.

8. The magnetic actuator according to any of claims 1 to 7, characterized in that the part (200) with reduced magnet weight includes a magnet frame (24).

9. The magnetic actuator according to any of claims 1 to 8, characterized in that the part (200) with reduced magnet weight includes in the direction of the displacement, a succession of magnets (26) spaced apart from each other, these magnets (26) having a same magnetization orientation.

10. The magnetic actuator according to any of claims 1 to 8, characterized in that the part (200) with reduced magnet weight includes in the direction of the displacement, an alternating succession of magnets

(26) and of at least one solid portion (27) of lesser density.

11. The magnetic actuator according to any
5 of claims 9 or 10, characterized in that the magnets
(26) are in the form of orientated bars substantially
normal to the displacement.

12. The magnetic actuator according to any
10 of claims 9 to 11, characterized in that the succession
includes a magnet (26) at each end.

13. The magnetic actuator according to
claim 12, characterized in that the end magnets (26)
15 have a dimension in the direction of the displacement,
substantially equal to the displacement.

14. The magnetic actuator according to any
of claims 9 to 13, characterized in that the means (30)
20 for triggering the displacement include at least one
conductor (30) arranged as a meander formed with
sections (30.1, 30.2) of successive conductors wherein
a current is able to flow in opposite directions, each
of the magnets (26) of the succession, when the mobile
25 magnetic portion (20) is stuck on the attraction area
(11, 12), cooperating with one of the sections (30.1 or
30.2), the current flowing in the same direction in
these sections.

15. The magnetic actuator according to any
30 of claims 1 to 7, characterized in that the part (200)

with reduced magnet weight includes at least one central magnet (28) surrounded at least partially by at least one portion (29) of lesser density, this central magnet (28) being in the form of a substantially rounded or ovoid pad.

16. The magnetic actuator according to any of claims 1 to 15, characterized in that the mobile magnetic portion (20) includes at least one face (201a), which must come and stick on an attraction area (11, 12), this face (201a) being curved.

17. The magnetic actuator according to any of claims 1 to 15, characterized in that the mobile magnetic portion (20) includes at least one face (205) which must come and stick on an attraction area (11, 12), this face being arranged as a zigzag.

18. The magnetic actuator according to any of claims 1 to 17, characterized in that each attraction area (11, 12) has a geometry conjugate to that of the face (201a, 205) of the mobile magnetic portion (20) which must come into contact with it.

19. The magnetic actuator according to any of claims 1 to 18, characterized in that at least one of the attraction areas (11) includes a dielectric portion (111) so as to achieve capacitive contact when the mobile magnetic portion (20) is stuck on said attraction area.

20. The magnetic actuator according to any of claims 1 to 19, characterized in that the part, with reduced magnet weight includes a dielectric portion (29) so as to achieve capacitive contact when the mobile magnetic portion (20) is stuck on one of the attraction areas (11, 12).

21. A method for making a magnetic actuator, characterized in that it includes the following steps:

- on a first substrate (91, 93), making cases (51) capable of receiving magnets (3-1, 24) of a fixed magnetic portion and a part (200) with reduced magnet weight, of a mobile magnetic portion, this part (200) with reduced magnet weight having an overall volume, and a mass which is less than the one it would have if its overall volume was totally occupied by the magnet,

- depositing magnets (3-1, 24) in the cases (51),

- depositing a dielectric layer (54) and etching the latter to expose the part (200) with reduced magnet weight of the mobile magnetic portion and its surroundings up to the fixed magnetic part,

- on a second substrate (92), making at least one case (55) capable of receiving a conductor for triggering a displacement of the mobile magnetic portion,

- depositing the conductor (4-1) in the case (55),

- assembling both substrates (91 or 93, 92)
by putting them face to face,

- totally or partially removing the first
substrate (91, 93) so as to release the part (200) with
5 reduced magnet weight from the mobile magnetic portion.

22. The method according to claim 21,
characterized in that it includes a step for
magnetizing the magnet (24) of the part (200) with
10 reduced magnet weight of the mobile magnetic portion
and possibly of the fixed magnetic portion before
releasing the part (200) with reduced magnet weight.

23. The method according to any of claims
15 21 or 22, characterized in that the step for etching
the dielectric layer (54) of the first substrate (91,
93) also aims at providing at least an aperture (46)
for accessing at least one electric contact for
supplying power to the conductor (4-1).

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24. The method according to claim 23,
characterized in that the step for etching the
dielectric layer (54) is followed by a step for etching
the first substrate (91, 93) around the part (200) with
25 reduced magnet weight and at the level of at least one
portion (21) of lesser density, with which the part
(200) with reduced magnet weight is provided.

25. The method according to claim 23,
30 characterized in that the step for etching the
dielectric layer (54) is followed by a step for etching

the first substrate (91, 93) around the part (200) with reduced magnet weight by masking at least one portion (21) of lesser density with which the part (200) with reduced magnet weight is provided, this portion (21) of lesser density being full of the material of the substrate.

26. The magnetic actuator according to any of claims 21 to 25, characterized in that it includes a step for achieving at least one electric contact (47) for supplying power to the conductor (4-1) on the second substrate (92) after depositing the conductor and before assembling both substrates (91 or 93, 92).

27. The magnetic actuator according to any of claims 21 to 26, characterized in that it includes a step for depositing dielectric material (59) at the surface of the second substrate (92) before assembling both substrates (91 or 93, 92).

28. The magnetic actuator according to any of claims 21 to 27, characterized in that the substrates are massive semiconducting or SOI type substrates (93).